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(54) **Marine gear system which can be shifted from fast mode operation to slow mode operation**

(57) In the kinematic connection between a main driving shaft (1) and an output shaft (3) there is located a clutch (8) whose secondary part (7) is connected to the planet carrier (18) of a planetary gear system (16). The shaft (21) of the sun-wheel (20) of the planetary gear system is driven from an auxiliary motor for low speed operation, and the annular wheel (22) of the planetary gear system can be held stationary with respect to a gear system housing (24) by means of a brake (23). The clutch 8 has teeth 10 engaging teeth 11 of a clutch 38 such that selective operation of these clutches provides forward or reverse drive between the shafts 1 and 3.

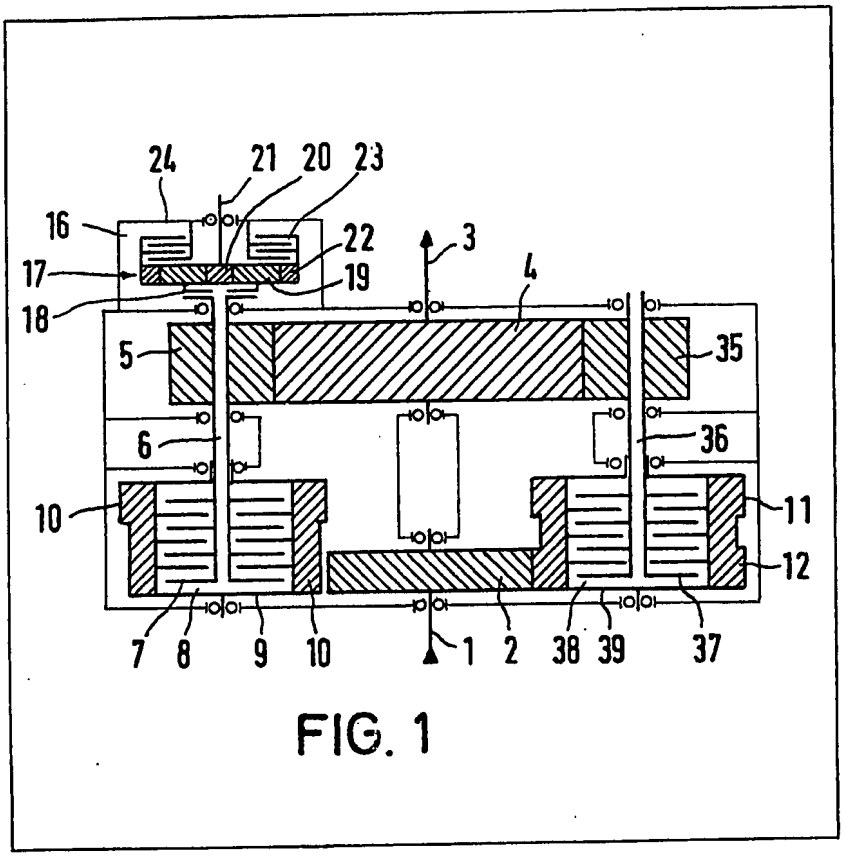

FIG. 1

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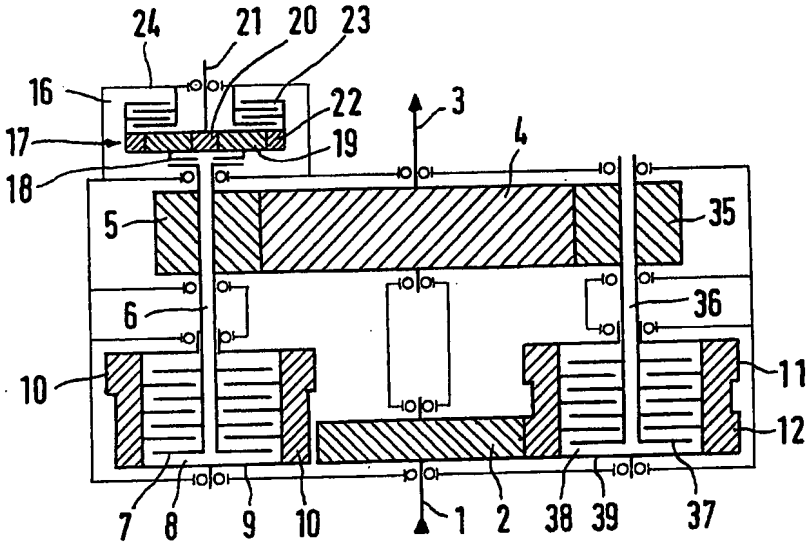
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FIG. 1

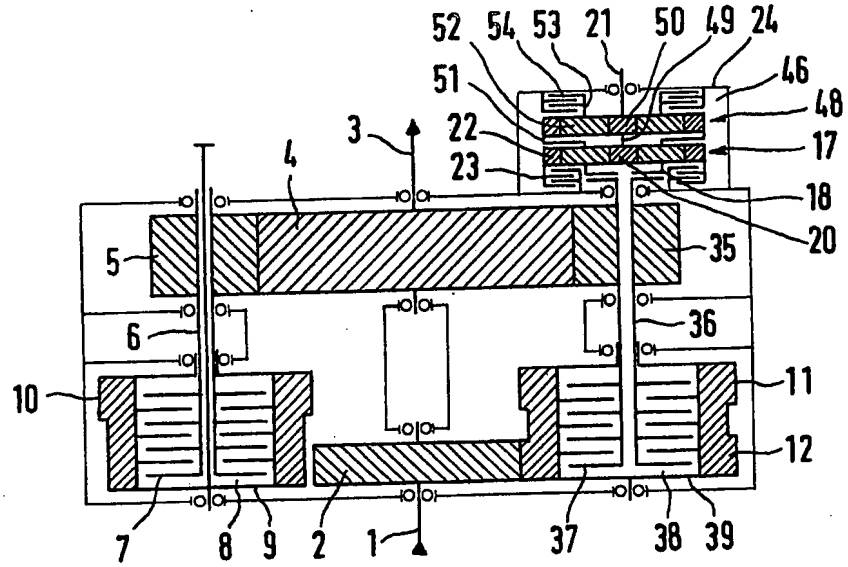
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FIG. 2

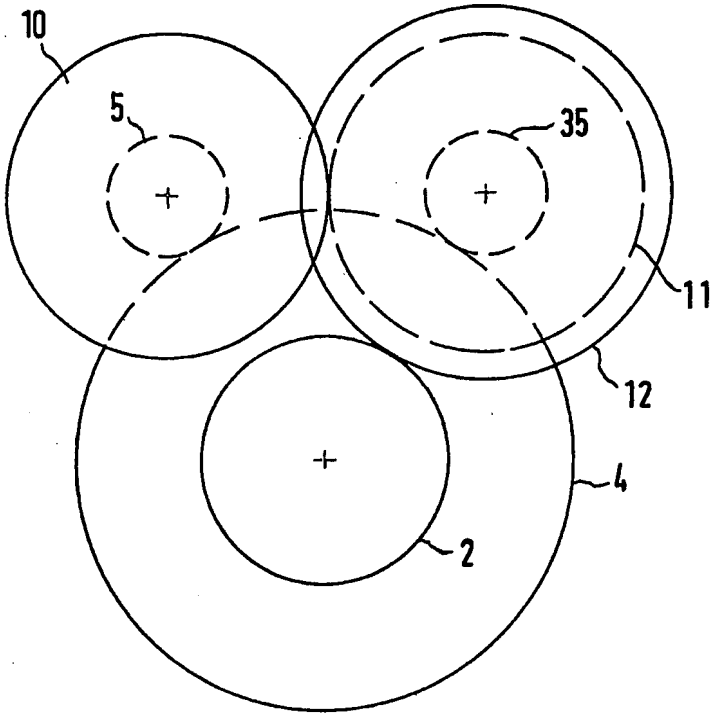

FIG. 3

SPECIFICATION

Marine gear system which can be shifted from fast mode operation to slow mode operation

This invention relates to a marine gear system which can be shifted from a high-speed mode to a low-speed mode, and which comprises a drive shaft, a take-off shaft, a clutch arranged in the kinematic path between these two shafts, and a planetary gear system comprising a sun-wheel, planet wheels, and a planet carrier, with the planet carrier connected to the second part of the clutch.

One such marine gear system is described in German patent specification DE—AS 29 13 385. There, the drive for fast mode operation and for slow mode operation is effected by a single main motor. In order to switch over, a planetary gear system with two planetary gearsets is provided, with the sun-wheels being capable of being held stationary by brakes and with their annular wheels connected by way of hydraulic coupling members.

Additionally, it is known to use a main motor for high-speed operation and a separate auxiliary motor for low-speed operation, in order to conserve energy and to avoid damage to the main motor by underloading it at low speeds. The propeller shaft of the vessel runs at a considerable reduced efficiency at reduced speeds of rotation in accordance with the laws or propeller design. The power consumption varies approximately with the third power of the speed of rotation.

It is an object of the present invention to produce a gear system which is simple, which is structurally compact and which can be produced economically.

This is achieved in accordance with the present invention, in a gear system of the type first referred to above, in that the sun-wheel of the planetary gear system is arranged to be rotated by an auxiliary drive shaft which is arranged to be driven by an auxiliary motor for low speed operation, and in which the planetary gear system includes an annular wheel which can be held stationary by a brake.

In one embodiment, the gear system is one in which the secondary part of the clutch and the planet carrier of the planetary gear system are connected to each other by an intermediate shaft which carries a driven pinion for driving a gearwheel on the take-off shaft, and in which the clutch is located on one side of said driven pinion and the planetary gear system is located on the other side of said driven pinion.

According to a preferred embodiment of the invention the planetary gear system comprises two planetary gearsets which are switched in a manner known per se to enable them to be used as a reversible or change-over gear system. This gives rise to the possibility of travelling either ahead or astern in the low-speed mode by means of the auxiliary motor. This can be achieved by a gear system in which the planetary gear system includes a second planetary gearset with the sun-wheels of the two planetary gearsets being connected to each other, the annular wheel of the second planetary gearset being connected to the planet carrier of the first planetary gearset, and the planet carrier of the second planetary gearset being capable of being held stationary by a brake.

Preferably, in order to provide a change-over gear system for the main drive, the drive shaft is provided with a drive pinion, a second clutch is provided having a secondary part which is connected kinematically to a gearwheel on the take-off shaft, the primary parts of the two clutches are connected kinematically to each other, and the drive pinion is connected kinematically to the primary part of only one of the two clutches.

In order that the invention may be fully understood, two embodiments of marine gear system in accordance with the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a schematic side view of a first embodiment of marine gear system in accordance with the invention;

Fig. 2 is a schematic view of a second embodiment of marine gear system in accordance with the invention; and

Fig. 3 is a schematic view of the driving shaft of a main drive provided for the gear system of Fig. 1 or Fig. 2.

The marine gear system shown in Fig. 1 comprises a driving shaft 1 which is powered by a main motor, a driving pinion 2 on the driving shaft, a take-off or driven shaft 3 carrying a gearwheel 4 and leading to the ship's propeller, a driven pinion 5 in meshing engagement with the gearwheel 4 and having an intermediate shaft 6 extending therethrough, one end of the intermediate shaft 6 being connected to the secondary part 7 of a clutch 8 whose primary part 9 is provided with external teeth 10 which are in engagement with external teeth 11 on a primary part 39 of a further clutch 38. Further external teeth 12 on the primary part 39 of clutch 38 are in engagement with the driving pinion 2.

On the side of the driven pinion 5 remote from the clutch 8 there is provided a planetary gear system 16 of an auxiliary drive comprising a planetary gearset 17, with a planet carrier 18 for the planet wheels 19 being connected to the adjacent end of the intermediate shaft 6. A sun-wheel 20 is set on an auxiliary driving shaft 21 which is powered from an auxiliary motor which is not shown. An annular wheel 22 of the planetary gearset can be held stationary with respect to a gear system housing 24 by means of a brake 23.

The gear system is designed as a change-over gear system, in which the further clutch 38 has its primary part 39 in engagement with the driving pinion 2 and its secondary part 37 connected by means of an intermediate shaft 36 and a driven pinion 35 to the driven gearwheel 4 on the take-off shaft 3.

The following operational states are possible:

(a) The clutches 8 and 38 are disengaged and the brake is released. Thus there can be not torque

transmission to the take-off shaft 3. When the main motor is switched on, the driving pinion 2 rotates only the primary parts 9 and 39 of the clutches 8 and 38 but not the secondary parts. When the auxiliary motor is switched on, the auxiliary driving shaft 21 rotates the annular wheel 22 as well as the sun-wheel 20 but without entraining the planet carrier 18, so that, again, no torque is transmitted to the take-off shaft 3 from the auxiliary drive.

(b) Clutch 8 is engaged and brake 23 is released, with clutch 38 disengaged. In this case a driving torque is transmitted from the driving pinon 2 to the take-off shaft 3 by way of the clutch 8 and the driven pinion 5.

(c) Both clutches 8 and 39 are disengaged and brake 23 is applied. In this case the annular wheel 22 of the planetary gear system 16 remains stationary and the planet carrier 18 is driven by the sun-wheel 20. This causes torque to be transmited from the planet carrier 18 to the take-off shaft 3 by way of the driven pinion 5.

(d) Clutch 38 is engaged, and clutch 8 and brake 23 are disengaged. Now, the take-off shaft 3 is driven from the driving shaft 1 by way of the further clutch 38 and the driven pinion 35 with a reversed direction of rotation as compared with clutch 8 engaged according to operation state (b) above.

The clutches 8 and 38 serve to transmit the comparatively high torque for high speed motion, while the brake 23 and the planetary gear system 16 serve to transmit the comparatively smaller torque for low speed motion.

If high speed travel in only one direction is all that is required, then clutch 38 and driven pinion 35 can be omitted. In this case the driving pinion 2 must be brought directly into engagement with the external teeth 10 of clutch 8.

According to a further possibility, the planetary gear system can be mounted on the intermediate shaft 36, instead of on the intermediate shaft 6. This alternative is shown in Fig. 2.

In the embodiment shown in Fig. 2 those parts which are the same as the corresponding parts in Fig. 1 are shown by the same reference numbers. In the gear system of Fig. 2 the planetary gearset 17 is contained within a planetary gear system 46, and a further planetary gearset 48 is also provided within this system. The two planetary gearsets 17 and 48 together form a reversible gear system for the auxiliary drive. In this way, the take-off shaft 3 can be driven at the comparatively low speed of rotation of the auxiliary drive both in a direction of rotation corresponding to the forward movement of the vessel and also in the other direction of rotation corresponding to the astern movement of the vessel. The sun-wheel 20 of the one set 17 is connected by means of a connecting member 49 to the sun-wheel 50 of the other set 48 and thus also to the auxiliary drive shaft 21. The planet carrier 18 of the one set 17 is connected by way of a connecting member 51 to the annular wheel 52 of the other set 48. The planet carrier 53 of the other set 48 can be held stationary with respect to the gear system casing 24 by means of a brake 54. By applying the brake 23 of the one planetary gearset 17, or by applying the brake 54 of the other planetary gearset 48, the take-off shaft 3 is driven in the one direction of rotation or the other by means of the auxiliary drive from the auxiliary driveshaft 21. The two planetary gearsets 17 and 48 together form an independent unit which can be connected in any chosen manner to the main gear system.

In Figures 1 and 2 the clutches 8 and 38 are shown spaced from one another for greater clarity in the drawings. In practice, the tooth rings 10 and 11 of the two toothed clutches 8 and 38 are in meshing engagement with one another. This can be appreciated from Fig. 3. The toothed wheels 10, 11 and 12 have to be shown as being of different sizes in order to give a clear representation of them, although they could equally well all be the same size.

CLAIMS

1. A marine gear system which can be shifted from a high-speed mode to a low-speed mode, comprising a drive shaft, a take-off shaft, a clutch arranged in the kinematic path between said two shafts, a planetary gear system comprising a sun-wheel, planet wheels and a planet carrier, the planet carrier being connected to the secondary part of the clutch, wherein the sun-wheel of the planetary gear system is arranged to be rotated by an auxiliary drive shaft which is arranged to be driven by an auxiliary motor for low-speed operation, and wherein the planetary gear system includes an annular wheel which can be held stationary by a brake.

2. A marine gear system as claimed in claim 1, in which the secondary part of the clutch and the planet carrier of the planetary gear system are connected to each other by an intermediate shaft which carries a driven pinion for driving a gearwheel on the take-off shaft, and in which the clutch is located on one side of said driven pinion and the planetary gear system is located on the other side of said driven pinion.

3. A marine gear system as claimed in claim 1 or 2, in which the planetary gear system constitutes a reversible gear system for the auxiliary drive, and in which the planetary gear system includes a second planetary gearset with the sun-wheels of the two planetary gearsets being connected to each other, the annular wheel of the second planetary gearset being connected to the planet carrier of the first planetary gearset, and the planet carrier of the second planetary gearset being capable of being held stationary by a brake.

4. A marine gear system as claimed in claim 2 or 3, in which, in order to provide a change-over gear system for the main drive, the drive shaft is provided with a drive pinion, a second clutch is provided having a secondary part which is connected kinematically to a gearwheel on the take-off shaft, the primary parts of the two clutches are connected kinematically to each

other, and the drive pinion is connected kinematically to the primary part of only one of the two clutches.

5. A marine gear system substantially as hereinbefore described with reference to Figs. 1 and 3 or Figs. 2 and 3 of the accompanying drawings.

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